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Research Article

EVALUATION OF UNDERGROUND WATER QUALITY FOR DRINKING PURPOSE BY WATER QUALITY INDEX AT AMROHA, UTTAR PRADESH

Nidhi Vema[1] and *Navneet Kumar[2]
[1]CMJ University, Shillong
[2]College of Engineering, Teerthanker Mahaveer University, Moradabad
**Author for Correspondence*

ABSTRACT
The present study carried out with the aim of understanding the groundwater quality and its suitability for domestic and irrigation purpose. The quality of water is vital concern for mankind since it is directly linked with human health. Groundwater is highly valued because it constitutes the major drinking and irrigation water source in most of the parts of India. Water quality index for underground drinking water at Amroha for twelve different sites has been calculated with the help of estimated values of water quality physico-chemical parameters and W.H.O. water quality standards. Underground drinking water at ten sites is found to be severely polluted. At a few sites it is moderately polluted and at one site fit for human consumption. People dependent on this water must be facing the health hazards of contaminated drinking water and water quality management is urgently required in the catchment area of study.

Keywords: *Underground Drinking Water, Physico-Chemical Parameter, Quality Rating*

INTRODUCTION
Groundwater quality is as important as the quantity. Poor quality of water adversely affects the plant growth and human health. It decreases agricultural production; reduce agrarian economy, retards improvement in the living conditions of rural people. Potable water is the water that is free from disease producing chemical substances and microorganisms that are dangerous to health, majority of the rural people do not have accesses to potable water for domestic use. Several regions in India have encountered degradation in groundwater quality too, due to increase of population growth and rapid urbanization. Groundwater is usually as direct use in rural water supply without proper treatment and for agricultural practice most of the year (Caleb, 2012; Mohan, 2007). Groundwater may also contaminated due weathering of rock and agrochemicals used for irrigation in this area. India is endowed with a rich and vast diversity of natural resources, water being one of them. Water is nature's most wonderful, abundant and useful compound. Of the many essential elements for the existence of human beings, animals and plants, water is rated to be of the greatest importance. Without food, human can survive for a number of days, but water is such an essential that without it one cannot survive (Pradhan, 2001; Freeda, 2006).
The environmental degradation that we see around is the result of a number of factors, the biggest of which is man himself. It is well known fact that clean water is absolutely essential for healthy living. Adequate supply of fresh and clean drinking water is a basic need for all human beings on the earth. The problem of drinking water contamination, water conservation and water quality management has assumed a very complex shape. Attention on water contamination and its management has become a need of hour because of far reaching impact on human health (Ramesh, 2012; Sinha, 2004).
Today human activities are constantly adding industrial, domestic and agricultural wastes to ground water reservoirs at an alarming rate. Ground water contamination is generally irreversible. It is always better to protect ground water first rather than relying on technology to clean up water from a contaminated source (Singh, 1999; Venkata, 2012).
Amroha is a 'C' class city of western Uttar Pradesh having a population more than 19 lakh as per the census of 2011. District Amroha lies in the west of Moradabad District adjoining Meerut, Hapur, Sambhal & Buland Shahar. The district consists of 1133 villages, 3 Tehsils, 6 Blocks & 11 Police Stations. Its geographical area is 2470 Sq. Km. Extending from Latitute 28° 54' North to 39° 6' North and

Longitude 78° 28' East to 78° 39' East. The maximum & minimum height from sea level are 240ft. and 177ft. respectively. In the north of the district lies district Bijnore, tehsil Sambhal of Moradabad is in the south, tehsil Sadar of Moradabad is in the east and in the west are situated districts Meerut, Ghaziabad & Buland Shahar. Ganga river separates it from district Ghaziabad, Meerut & Buland Shahar. Amroha has gone through rapid industrialization and population growth during last few decades. Some industries are causing underground water pollution in area of our study and therefore, an attention is urgently needed.

MATERIALS AND METHODS

India Mark II (IM2) hand pump water at twelve different sites at Amroha district was collected. Standard methods and procedures were followed for water quality physico-chemical parameters (APHA, 1998; Merck, 1974). All the chemicals of Analytical Reagent (AR) grade were used, unless otherwise stated for analytical purposes. Three samples of each site were collected, analyzed and arithmetic mean of three values is reported here. A blank was also run for all volumetric titrations. The specifications of used instruments are Century CP 901 pH meter, RI Conductivity meter and Hach 2010 (version 6.4) spectrophotometer. The estimated parameters are pH, conductivity, total hardness, calcium, chemical oxygen demand, biological oxygen demand, alkalinity, chloride, total dissolved solids and fluoride. A brief description of sampling sites is given in Table-1.

Water quality index (WQI) of underground drinking water collected at all sites were calculated using data of estimated parameters and WHO standards (WHO, 1971) by methods proposed by Horton and modified by Tiwari and Mishra (Horton, 1965; Tiwari, 1985). According to the role of various parameters on the basis of importance and incidence on overall quality of drinking water, rating scales were fixed in terms of ideal values of different physico-chemical parameters. Even if, they are present, they might not be ruling factor. Hence they were assigned zero values. For calculating WQI following equations are used:

1. Quality rating, $Q_n = 100[(V_n - V_i) / (V_s - V_i)]$

   Where, V_n - Actual amount of n^{th} parameter
   V_i - The ideal value of this parameter
   $V_i = 0$ except for pH and D.O.
   $V_i = 7.0$ mg/lit for pH and
   $V_i = 14.6$ mg/lit for D.O.
   V_s – Its standard

2. Unit weight (W_n) for various parameters is inversely proportional to the recommended WHO standard (S_n) for the corresponding parameter.

   $W_n = K/S_n$
   Where, S_n = recommended standard
   K = constant
   $\sum W_n = 1$, considered here

3. The overall WQI is calculated by taking geometric mean of these sub indices.

   $WQI = \text{antilog}_{10} [\sum W_n \log_{10} Q_n]$

To include the collective role of various physico-chemical parameters on the overall quality of drinking water, quality status is assigned on the basis of calculated values of water quality indices. On the basis of a number of water pollution studies following assumptions are made with reference to assess the extent of contamination or the quality of drinking water. The assumptions are:

WQI < 50 : fit for human consumption;
WQI < 80 : moderately contaminated;
WQI > 80 : excessively contaminated;
WQI > 100 : severely contaminated.

RESULTS AND DISCUSSION

Site-wise and parameter-wise estimated values of underground drinking water quality parameters are presented in Table-2. Parameter-wise W.H.O. standards and assigned unit weights are listed in Table-3. Final calculated site-wise values of water quality index (WQI) are given in Table-4.

Table 1: A brief description of sampling sites

S.No.	Site No. & Name	Location of site	Apparent water quality	Usage
1	I, Amroha Block	3.0 km North-East from Railway Station	Pale yellow on standing, odourless	Drinking & Bathing
2	II, Tehsil Amroha	6.0 km West from Railway Station	Colourless, odourless	Drinking & Bathing
3	III, Shah Vilayat Dargah Square	1.5 km South to site no. II	Colourless, odourless	Drinking & Bathing
4	IV, Vashu Dev Tirth	2.5 km West to site no. III	Pale yellow on standing, foul smell	Drinking, Washing & Bathing
5	V, Railway Station	6.0 km East Tehsil	Pale yellow on standing, odourless	Drinking, Washing & Bathing
6	VI, Lakra Square	4.0 km West to site no.II	Pale yellow on standing, foul smell	Drinking & Bathing
7	VII, Hasanpur Bus Stop	6.0 km South to site no.II	Colourless, odourless	Drinking, Washing & Bathing
8	VIII, Dhanora Bus Stop	7.0 km South-West to site no.II	Colourless, odourless	Drinking, Washing & Bathing
9	IX, District Court	4.5km South-West from Railway Station	Colourless, odourless	Drinking & Bathing
10	X, Nagar Palika Parishad	5.0 km South to site no.II	Pale yellow on standing, odourless	Drinking & Bathing
11	XI, Collectrate Amroha	0.5 km South to site no.IX	Colourless, odourless	Drinking & Bathing
12	XII, Roadways	2.0km South from Railway Station	Colourless, odourless	Drinking & Bathing

Table 2: Site-wise and parameter-wise estimated values of underground drinking water quality parameters

S.No.	Parameters	Site No. I	Site No. II	Site No. III	Site No. IV	Site No. V	Site No. VI	Site No. VII	Site No. VIII	Site No. IX	Site No. X	Site No. XI	Site No. XII
1	pH	7.72	7.68	7.43	7.33	7.95	7.70	7.39	8.01	7.85	7.55	7.60	7.45
2	Conductivity(µS/cm)	0.781	0.791	0.670	0.580	0.970	0.532	0.500	1.010	1.001	0.631	0.535	0.430
3	Total Hardness(mg/L)	350	380	285	270	550	320	335	450	535	340	355	320
4	Calcium(mg/L)	255	280	215	220	455	280	290	410	495	255	285	265
5	Chemical Oxygen Demand(mg/L)	28	23	35	20	50	18	20	42	40	35	32	34
6	Biological Oxygen Demand(mg/L)	22	16	25	15	25	15	14	25	28	17	14	13
7	Alkalinity((mg/L)	235	238	240	210	300	180	225	320	280	160	185	310
8	Chloride(mg/L)	61	81	56	65	165	80	69	150	170	72	85	67
9	Total Dissolved Solids(mg/L)	710	680	715	685	795	705	690	805	790	685	675	710
10	Fluoride (mg/L)	0.32	0.50	0.40	0.63	0.62	0.30	0.21	0.53	0.41	0.21	0.11	0.17

Table 3: Parameters- wise W.H.O. standards and their assigned unit weights

S.No.	Parameters	WHO standard	Assigned Unit Weights (W_n)
1	pH	-	0.017617
2	Conductivity(µS/cm)	0.300	0.469793
3	Total Hardness(mg/L)	100	0.001409
4	Calcium(mg/L)	100	0.001409
5	Chemical Oxygen Demand(mg/L)	10	0.014093
6	Biological Oxygen Demand(mg/L)	6	0.023489
7	Alkalinity((mg/L)	100	0.001409
8	Chloride(mg/L)	200	0.000704
9	Total Dissolved Solids(mg/L)	500	0.000281
10	Fluoride (mg/L)	1	0.469793

Table 4: Site-wise calculated values of water quality index (WQI)

S. No.	Number and Name of Site	Water Quality Index (WQI)
1	I, Amroha Block	169
2	II, Tehsil Amroha	207
3	III, Shah Vilayat Dargah Square	174
4	IV, Vashu Dev Tirth	196
5	V, Railway Station	260
6	VI, Lakra Square	134
7	VII, Hasanpur Bus Stop	109
8	VIII, Dhanora Bus Stop	245
9	IX, District Court	216
10	X, Nagar Palika Parishad	124
11	XI, Collectrate Amroha	84
12	XII, Roadways	17

A Critical analysis of the values of the WQI presented in Table-4 and its comparison with the standard assumptions reveals some meaningful facts regarding the drinking water contamination at Amroha during the course of study.

The observed range of WQI is 17 –260 in the catchment area and during the course of study. The maximum range of WQI is noticed at site no. V and the minimum range is XII. The underground drinking water is found to be severely polluted at all the sites with the value of WQI>100. The underground drinking water of site no. XI is found to be moderately polluted with the value of WQI and at one site fit for human consumption.

Conclusion

Drinking water at Amroha is severely polluted at almost all the sites of sampling. At a one site drinking water is moderately polluted during the course of study. Therefore, one may conclude that drinking water in the catchment area of sampling is highly polluted and is unfit for human consumption and domestic purposes. In the other way it can also be said that drinking water is severely polluted with reference to the water quality parameters studied. People dependent on this water must be suffering from the health hazards of contaminated drinking water. Some strict and effective measures for drinking water quality management at Amroha are urgently required. Water quality index is again proved to be an important tool for the assessment of water quality.

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